# RESEARCH PLAN PROPOSAL

**Leaf Litter Management: A Comparative Study of the Effects of Traditional and Commercial Composts on the Growth and Productivity of *Ocimum sanctum* (*Tulsi*)**

For the registration to the degree of Doctor of Philosophy

## IN THE FACULTY OF SCIENCE

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## Submitted by

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# INTRODUCTION

Environmental degradation is a major threat confronting the world. The primary causes of environmental degradation in a country could be attributed to rapid growth of population, over utilization of environmental resources, establishment of different multinational companies and local industries which adversely affect the natural resources and environment. Air pollution, water pollution, deforestation, thinning of the ozone layer, global warming, sanitation and outbreaks of diseases are the problems that are endangering human lives. Besides these, the problem of waste disposal cannot be ruled out.

Wastes according to Tchobanoglous and Kreith (2002) are discarded tangible products of human activities that are regarded as unwanted and useless. Waste can be solid or liquid. Solid waste can either be organic or inorganic such as product packaging, grass clipping, furniture, clothing, kitchen refuse, paper.etc produced in society .

Solid waste comprises of all the wastes arising from human and animal activities that are normally solid and are discarded as useless. Solid waste consists of heterogeneous mass of discarded materials from commercial, industrial, agricultural, institutional and domestic waste (Diwevdi and Wagay , 2014).

| **Source** | **Typical facilities, activities, or locations where wastes are generated** | **Types of solid wastes** |
|---|---|---|
| Residential | single family and multifamily cardboard , plastics , high-density apartments ; etc. | Food wastes , paper, cardboard , plastics, dwellings; low, medium-,and textiles , leather , yard wastes , wood ,high -density apartments ; etc. glass , tin cans , aluminium , other metal , ashes , street leaves , special wastes (including |
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| | | bulky items, consumer electronics, white goods, yard wastes collected separately, batteries, oil, and tires), and household hazardous wastes |
| Commercial | Stores, restaurants, markets, office buildings, hotels, motels print shops, service stations, auto repair shops, etc. | Paper, cardboard, plastics, wood, food wastes, glass, metal wastes ashes, special wastes hazardous wastes, etc. |
| Institutional | Schools, hospitals, prisons, governmental centres, etc. | Same as for commercial |
| Industrial (non-process wastes) | Construction, fabrication, light and heavy manufacturing, refineries, chemical plants , power plants, demolition, etc. | Paper, cardboard, plastics, wood, food wastes, glass, metal wastes, ashes special wastes (see preceding), hazardous wastes, etc. |
| Municipal solid waste | All of the preceding | All of the preceding |
| Construction and demolition | New construction sites, road repair, renovation sites, razing of buildings, broken pavement, etc | Wood, steel, concrete, dirt, etc. |
| Municipal services (excluding Street treatment facilities) | Street cleaning, landscaping catch-basin cleaning, parks and beaches, other recreational areas, etc. | Special wastes, rubbish, street sweepings landscape and tree trimmings, catch basin debris; general wastes from parks, beaches, and recreational areas |
| Treatment facilities | Water, wastewater, industrial | Treatment plant wastes, |

| | | |
|---|---|---|
| | , treatment processes , etc. | principally composed of residual sludges and other residual materials |
| Industrial | Construction , fabrication light and heavy manufacturing materials, refineries , chemical plants , power plants , demolition , etc. | Industrial process wastes, scrap materials, etc.; nonindustrial waste including food wastes, rubbish, ashes, demolition and construction wastes, special wastes, and hazardous waste |
| Agricultural | Field and row crops, orchards, vineyards, dairies, feedlots , farms , etc | Spoiled food wastes, agricultural, wastes, rubbish, and hazardous wastes |

**Table 1: Various sources of solid waste along with their generation source**

Source: Sources of solid waste (Tchobanoglous and Kreith , 2002)

Management of solid waste resulting from rapid urbanization has generated a lot of concern in most developing countries. Especially during the last decade the volume and complexity of solid waste generated particularly in large cities, have been increasing at an unprecedented rate. This increase has been attributed to two main drivers: intensification of urbanization and rising living standards (Rathi , 2007). The Solid Waste Management (SWM) system comprises four activities: waste generation, collection, transportation and disposal (Sharholy *et al* ; 2007).

Solid waste management therefore requires adequate infrastructure provision and maintenance for all four activities. When not managed adequately, solid waste generates several public health and environmental hazards. The increasing volume and complexity of solid waste pose the greatest challenges to large cities in developing countries, where organization and planning of solid waste collection and disposal services tend to be rudimentary. Due to budget and infrastructure constraints, public authorities in these cities are often unable to manage large amounts of solid waste generated. This fact is reflected in the unknown volume and types of solid wastes collected; amount recovered and recycled; the inadequacy of disposal sites, as well as efficient reutilization and recycling programmes(Buenrostro and Bocco , 2003).

The solid waste can be utilised by different methods for preparing various useful products such as compost , dyes, biogas , incense sticks, vermicompost etc. In this study leaf litter will be utilised to prepare different types of composts.

# LEAF LITTER

Leaf litter is dead plant material that has fallen to the gound. Leaf litter accumulation in urban and suburban locations such as sidewalks, lawns, and playgrounds is not only an unseemly sight but adds to the overall problem of municipal solid waste disposal.

In many countries, including India, leaf litter is often piled-up and set on fire. The resulting ash returns some of the NPK content of the litter to the soil but much of nitrogen, phosphorus and organic carbon gets lost. The burning of litter also adds to air pollution (Abbasi and Ramasamy , 1999.). The burning of leaf litter causes several health problems , especially respiratory like asthma and heart diseases(Sannigrahi , 2009). The conversion of a negative waste into beneficial material is an important aspect of resource recycling and environmental cleaning (Tripathi and Bhardwaj , 2004). Leaf litter are a potential energy resource if properly and biologically converted to organic matter (Mall *et al* ; 2005). Leaf litter in forest can cause serious fire incidents. For example- Leaf litter of Chir pine trees that are highly combustible , causes serious fire in the forest of Uttarakhand in summer of 2016. Management of leaf litter is very important to prevent incidents of forest fires , air pollution etc.

# COMPOSTING

Compost is becoming an important aspect in the quest to increase productivity of crops in an environment friendly way (Tejada *et al ;* 2009). Composting is a biological process to convert biodegradable waste into nutrient rich compost. Compost can be prepared by different methods such as cow's urine, by making fermented slurry of waste , by enzymes culture and by using earthworms culture.

For a long period, composting has been used as a biological process that deals with organic waste and in modern decades few species of earthworms are used in the composting process (vermicomposting) that makes the process more beneficial. Today, community understanding of vermicomposting process has increased; and its use to convert biodegradable waste into vermicompost has been progressively extended (Tejada *et al ;* 2009). In this process, the worms feed on organic materials with the help of some bacteria, as they accelerate the decomposition of

organic materials. These bacteria have positive effects on stabilization and making minerals available to plants (Rostami , 2011). Vermicomposting is a sustainable solution for management of organic wastes. It is an inexpensive process and can be implemented anywhere for solid waste management. In this sense, vermicomposting is compatible with sound environmental principles that value preservation of resources and sustainable practices, and thus, can be a suitable option for the safe, clean and cost effective disposal of the organic fraction of solid wastes. Vermicompost is a nutrient-rich, natural fertilizer and soil conditioner. It is known to be one of the best organic fertilizers. It consistently promotes biological activity which can cause plants to germinate, flower, grow and yield better than in commercial container media; independent of nutrient availability (Atiyeh *et al ;* 2000 a, b; Arancon *et al* ; 2004).

Natueco farming is a method of holistic farming to meet the needs of farming and food today. Its goal is to maximize carbon or biomass and not necessarily maximize economic gain in the narrow sense. It is also about maximizing output with minimum input in energy terms. The fundamental belief system in Natueco concept is that it is a science of life and life is all about energy. Natueco is not about farming and definitely not about farming for production and distribution. Amrut Mitti is the key ingredient of the Natueco farming. Also called as 'Nursery' Soil, 'Masala Mitti' or 'Living Soil', Amrut Mitti is a form of compost which forms the basis of the Natueco process of building fertile soil. While Nature takes centuries to produce fertile soil, a farmer can create this soil in his own farm in the form of Amrut Mitti in less than five months . It is the process of accelerating the creation of top soil in nature, through positive human involvement to reduce nature's time cycles. Amrut Mitti has all the qualities of a typical fertile soil – presence of living organisms, adequate moisture and aeration. The key characteristics of this 'Natueco Farming' technology of growing crops are (a) plants are grown on small 'heaps of Amrut Mitti' covered with mulch, hence no ploughing, (b) the heaps are always kept moist (watering with rose cans at the rate of 1000L water per day per 10 Gunta), (c) need based sowing and harvesting of crops – overall it looks like a 'constructed forest', (d) does not need any external input in terms of the agro-chemicals like fertilisers, insecticides, pesticides etc.(e) weeds are allowed to grow until flowering and are seen as a resource, (f) high diversity on a small piece of land- over 125 crop species with a mix of annuals and perennials on 10 Gunta, (g) trenches around the farm for rain water harvesting and (h) live fencing around each farm created for multiple purposes.

Amrut Mitti contains number of micro and macro fauna. Its use along with surface mulch creates conducive environment for regeneration of 'soil life' indicated above. And together, functioning as a 'soil food web' results in a slow release system of all the different nutrients needed for plant growth. (Suchde and Rupela , 2015).

## *OCIMUM SANCTUM* (*Tulsi*)

The world is rich with natural and individual medicinal plants. Medicinal plants study are now getting more interest than ever because they have many advantages to society or to all mankind, especially in the line of medicine and pharmacology (Krishnaiah *et al* ; 2009). Over three-quarters of the world population depends basically on plants and plant extracts for health care. More than 30% of the entire plant species, at one time or another, were utilized for medicinal purposes (Joy *et al* ; 1998). The medicinal values of plants lie in their phytochemicals, which makes specific physiological actions on the human body. Phytochemicals are compounds found in plants that are utilized as food and medicine top reserve against illness and to ensure human health. Phytochemicals have antioxidant or hormone –like impact which helps in fighting against many diseases including cancer, heart disease, diabetes and high blood pressure (Prasad *et al* ; 2012).

*Ocimum sanctum* belongs to the family Lamiaceae and is known as *Tulsi* in Hindi , Holy Basil in English and Rehan in Arabic. It is known to have various pharmacological activities. Many studies have determined that basil extracts have effective antioxidant, anti-aging, anticancer , and antimicrobial properties (Sakr *et al* ; 2011). It can also be utilized on common cold, cough, fever. It is used as mosquito and insect expeller (Devendran and Balasubramanian , 2011). *Ocimum sanctum* plant contains vitamin C and A, and minerals like calcium, zinc and iron, as well as chlorophyll and many other phytonutrients. It also enhances the efficient digestion, absorption and use of nutrients from food and herbs (Pattanayak *et al* ; 2010). Its essential oil is extensively employed in several countries for flavouring and foodstuffs, confectionary goods, condiments and toiletry products such as mouthwashes and dental creams. It is also used in flavouring of foods such as spices, meats, sausages, fancy vinegars, pickles, ketchups and beverages (Kirtikar and Basu, 1933; Samant *et al* ; 1998).

# REVIEW OF LITERATURE

Humankind has a role in shaping its environment. It has been accountable for the deteriorating quality of its environment ever since it came into being on this planet. Environment is our fundamental resource for development, and its optimal utilization and sensible management is important for progress. Human beings' very survival depends on their adaptation to the environment (Manimozhi *et al ;* 2006).

# WASTE

Solid waste may be defined as generation of undesirable substances which is left after they are used. Solid wastes comprise of various organic and inorganic materials. Due to massive increase in population, exploitation of natural resources has also increased. Therefore it is necessary to utilize the available natural resources efficiently. The increasing trends of population have also increased the rate of generation of solid waste. In India, rate of generation of solid waste was 27.8% in 2001 and expected to reach 41% by 2021. Currently total solid waste generated in India is around 42 million tonnes annually. Waste generation varies from 200-600 kg/capita/day and collection efficiency ranges from 50-90% ( Rajput *et al* ; 2009).

Solid waste can be of various types depending upon their sources of origin. Ramachandra (2011) described types of waste depending upon their sources of origin as agricultural, industrial, commercial and institutional and municipal solid waste. The accumulation of waste has increased together with rapid rise in residential colonies, fast food outlets, vegetable markets, fruit shops and other customer outlets in respective areas.

Solid waste management refers to separation, storage, collection, transportation and final disposal of waste in a sustainable manner. It therefore comes out as a necessary and specialised sector for keeping cities healthy and liveable. The problems associated with solid waste management are more acute in a developing country than in a developed country (Ramachandra and Bachamanda , 2006). Jamaludin (2001) argued that complications of waste management covers not only effects of the management approach itself, but also the mechanism within the system, such as those effects derived from transportation activities to final disposal sites from households or transfer stations.

Bundela *et al* (2010) reviewed the agricultural utilization of municipal solid waste compost(MSWC) is the most cost effective MSW management option over traditional means such as landfilling or incineration as it enables recycling of potential plant nutrients.

Ahmed and Quader (2011) proved through their study that the poor disposal and handling of waste leads to environmental degradation, damage of the ecosystem and poses great risks to public health in Narayanganj city.

Ganga, the national river of India is now polluted due to construction of dams and barrages, discharge of untreated municipal and industrial wastes, floral offerings, cremation of dead bodies on its bank. Kanpur to Trighat is the most polluted section of the river and needs special strategies and action plans to rejuvenate (Das , 2011).

A comparative study of solid waste generation at Mansa devi and Chandi devi temples during the kumbh mela 2010 was performed by Kaushik and Joshi , 2011. The total amount of solid waste generated for seven days of collection was 7615.0 kg and 4992.7 kg at Mansa devi and Chandi devi temples.

A study was undertaken by Diwevdi and Wagay (2014) with the aim to represent the status and need of solid waste management in Bhanpur, Bhopal. Through their study they proved that Compostable municipal solid waste has been used successfully to improve the physical and chemical properties of soils and increase the growth of crops and composted landfill waste has many potential uses in producing various agricultural crops.

# LEAF LITTER

Disposing – off the considerable quantity of leaf litter produced by trees growing in the forests , along the roads , rail lines , in the backyard , etc. has always been a problem. Improper management of such wastes (burning of leaf litter and uncared dumping in public places ) and intensive use of synthetic fertilizers and chemical pesticides since the green revolution some five decades ago has deteriorated the health of the environment to a large extent. In the rural areas , residents generally collect and use leaf litter as biomass fuel for cooking. In India , approximately 5 lakh women and children die due to indoor air pollution caused by using soild biomass as cooking (Sannigrahi , 2009).

Vermicomposting is an easy and effective way to recycle leaf litter along with bioconvesion of organic waste materials into nutritious compost by earthworm activity (Mall *et al* ; 2005).

Composting of leaf litter using the epigeic, exotic earthworm *Eisenia fetida* and the microbial kinetizer (Quikompost) was carried out by Perumalsamy and Roobak , 2009 in order to compare their efficacies in waste management. They showed that the quantity of leaf litter composted and the biomass (earthworm/microbial) recovered after composting were increased with increasing the quantity earthworm/microbial kinetizer. The production of compost was comparatively higher in microbial composting. Both the compost showed a stabilization pH of about 7.8 and 7.9. The electrical conductivity and moisture content were slightly higher in vermicompost than in microbial compost. The organic carbon content in vermicompost and microbial compost were increased with increasing number of earthworms and microbial kinetizer respectively. The value of nitrogen, phosphorous and potash were lesser in the microbial compost compared to vermicompost. However, the C/N ratios were more or less the same in both the types of compost. A study to evaluate the efficiency and the nutritional status of vermicompost processed by two earthworm species, *Eisenia fetida* and *Eudrilus eugeniae* from leaf litter and sugarcane trash was done by Alagesan and Dheeba (2010) . Chemical analysis of the vermicompost obtained from leaf litter showed that the quantity of organic carbon was reduced from 38.65 to 28.89 and 28.0% by *E. Fetida* and *E. eugeniae* respectively. The level of nitrogen (1.30%), phosphorus (0.38%), potassium (0.57%) and calcium (0.70%) was maximum in leaf litter vermicompost processed by *E. eugeniae* than *E. fetida*. Similarly, *E. eugeniae* processed leaf litter compost treated with plant, *Abelmoschus esculentus* showed maximum height (61.4cm), number of leaves (16 per plant), leaf area (265 $cm^2$), fruit length (15.8cm), fruit weight (17.9gm) and total chlorophyll content (3.78 mg/g.fresh wt) than those treated with sugarcane trash.

Jayanthi *et al* (2010) conducted a study on the processed mixed leaves litter in which the litter was mixed with cured cow dung in different proportions viz.,50:50 & 60:40 & 70:30 (each concentration in triplicates). Litter and cow dung were taken in the plastic trays in different concentrations. Hundred *Eudrilus euginiae* mature earthworms were added into each of these trays. Along with that, a control (without earthworms) was also run for each of these concentrations. The conversion ratio of mixed leaves litter into vermicompost was observed to be almost same in all the concentrations. Desired level of plant nutrients were found in vermicompost collected from all the three concentration. The outcome of this study implied that

the mixed leaves litter with cured cow dung at any of these concentrations could be applied for converting into vermicompost by employing the earthworm *E.eugeniae.*

An investigation was conducted to analyse the various physico-chemical parameters like pH, electrical conductivity, moisture content, organic carbon and C/N ratio in vermicomposting of leaf litter by *Lampito mauritti* (Priya and Prabha, 2011). Vermicomposting of leaf litter by Lampito *mauritti* resulted in significant increase of all the physico-chemical parameters as the composting time increases except C:N ratio.

A study was performed by Jesikha *et al* (2012) to evaluate the potential of epigeic earthworm *Eudrilus eugeniae* to transform waste leaf litter and waste cattle manure into a more useful vermicompost. Vermicomposting caused significant increased in available macro nutrients such as nitrogen 14.9%, potassium 1.69%, phosphorus 1.46% in leaf litter vermicompost and nitrogen 1.62%, potassium 0.56% , phosphorus 1.11% in cattle manure vermicompost, and reduction in carbon nitrogen ratio 0.33% and 2.76% in leaf litter vermicompost and cattle manure vermicompost respectively.

Mujeebunisa *et al* (2013) analysed the effect of leaf litter, vegetable waste, coffee waste, flower waste and may flower waste added vermicompost on weight gain in *Eudrilus eugeniae*. They observed an increased weight in vegetable and flower waste exposed worms when compared to coffee seed and may flower waste exposed worms. The study revealed that vermicomposting of organic wastes accelerates organic matter stabilization and gives chelating and phytohormonal elements which have a high content of microbial matter and
stabilized humic substances.

Arumugam *et al* (2014) investigated the enhancement of vermicomposting by the addition of leaf litter (nitrogen source) along with the post-consumer waste (PCW), the artificial paper banana leaf waste (APBL) . Physico-chemical parameters (pH, Electrical conductivity (EC), Total organic matter (TOM), Total Nitrogen (TKN), C: N and Total Phosphorus) were analyzed. They found that the aging of vermicompost reduce the microbial biomass. The study revealed that addition of leaf litter certainly augmented the PCW degradation apparently within a period of 50days,but degradation without leaf litter took 90days.

Thangaraj (2015) studied the inter-specific interactions in terms of growth, maturation, survival and vermicomposting efficiency of two earthworm species *Drawida modesta* (indigenous) and

*Eudrilus eugeniae* (exotic) exposed to leaf litter waste of *Pongamia pinnata*. Vermicompost was produced in 40 days by the decomposition of leaf litter waste by both the species. The vermicompost had an increased level of nutrients like total nitrogen, available phosphorus, available potassium and decreased level of ph, organic carbon and C:N ratio.

# COMPOSTING

The rapid use of chemical fertilizers contributes largely to the deterioration of environment through depletion of fossil fuels, generation of carbon dioxide and contamination of water resources(Aveyard , 1988). It leads to loss of soil fertility due to imbalanced use of fertilizers that has adversely impacted agricultural productivity and causes soil degradation(Wani and Lee , 1992). Now there is a growing realization that the adoption of ecological and sustainable farming practices can only reverse the declining trend in the global productivity and environment protection(Wani *et al* ; 1995).

Composting is a biological process in which organic biodegradable wastes are converted into hygienic, humus rich product (compost) for use as a soil conditioner and an organic fertilizer (Popkin , 1995).

A greenhouse study was conducted by Hernandez *et al* (2010) to evaluate the effect on total growth and leaf nutritional content in lettuce (*Lactuca sativa* L.). Three types of fertilization treatments were analyzed: two organic and one conventional or inorganic. Both vermicompost and compost were produced from cattle manure in a 25-week process. The results showed differences in weight and leaf content for the N and K variables, and the highest mean values for these variables were in the urea treatment. Leaf content of Ca, Mg, and Mn showed higher values in organic fertilization treatments. The vermicompost treatment showed a higher contribution of Mg, Fe, Zn, and Cu,and lower Na in lettuce leaf content when compared to compost usage.

Zafar *et al* (2012) studied the effect of compost (COM) and four inorganic phosphorus (P) sources, diammonium phosphate (DAP), single super phosphate (SSP), nitrophos (NP) and triple super phosphate (TSP) either alone or in combination on growth, yield and nutrient uptake of maize and their effect on soil properties. The results indicated that conjunctive use of inorganic P sources and COM significantly increased plant height, leaf area and chlorophyll content. Grain, dry matter, biomass yield and protein content increased by 10-61, 40-67, 30-67 and 17-46% over

control. P uptake increased 17 g kg-1 in control to 29 g kg-1 where DAP and COM was combined. The results also indicated that combine use of inorganic P with COM resulted in significant increase in total N (13−75%), available P (7−57%) and available K (7−20%) compared to control.

Vermicomposting is a simple biotechnological process of composting in which certain species of earthworms are used to enhance the process of waste conversion and produced a better end product (Gandhi *et al* ; 1977).

Joshi and Sharma (2010) conducted a study to analyze the physical and chemical characteristics of raw press mud, its compost and its vermicompost which was prepared by using *Eisenia foetida.* While comparing physical and chemical characteristics it was found that vermicompost had lower temperature, water holding capacity, pH and carbon content but higher EC, available phosphorus and moisture content as compared to pressmud and its compost.

A study was conducted by Ramasamy *et al* (2011) on different concentrations of vermicompost produced by earthworm, *Eudrilus eugeniae*. Maize plants (*Zea mays* L.) were grown on different ratios of vermicompost-enriched soil for 90 days. The plants were harvested at the end of 90 days and the kernels were collected. The number of kernels was counted; the length, breadth, and circumference of kernels were measured; the weight of kernel and total weight of all kernels were calculated. It was revealed that the addition of vermicompost to soil greatly enhanced the kernel yield in maize.

An experiment was conducted to determine the effect of vermicompost and other fertilizers on growth, yield and fruit quality of tomato in the field condition by Meenakumari and Shekhar (2012). The field trails were conducted using different fertilizers having equal concentration of nutrients to determine their impact on different growth parameters of tomato plants. Six types of experimental plots were prepared including control. Vermicompost supplemented with N.P.K treated plots displayed better results with regard to fresh weight of leaves, dry weight of leaves, dry weight of fruits, number of branches and number of fruits per plant from other fertilizers treated plants.

Bhat and Limaye (2012) studied the nutrient status and plant growth promoting potential of prepared vermicompost. Compost and plain soil were kept as control. The physico-chemical parameters like pH, organic carbon, nitrogen, average phosphorus, calcium, magnesium and chloride content were analyzed at regular intervals, over a period of 48 days. Flowering capacity,

height of plant, breadth and length of leaves was found more in vermicompost as compared to controls.

John and Prabha (2013) analysed the effect of vermicompost on the growth and yield of *Capsicum annum*. The main aim of this investigation was focused on the assessment of the potency of selected earthworm species *Eudrilus eugeniae* with respect to their biodegradation of Lady's finger waste into organic manure known as vermicompost. The study was carried out to estimate macro and micronutrients, physiochemical parameters, enzymes and biochemical parameters in vermicompost before and after inoculation of earthworm species and also a comparative study was done on the effect of vermicompost on the growth parameters namely shoot length and number of leaf count in *Capsicum annum*.The results of the study revealed that the total macronutrients and micronutrients showed elevated levels in vermicompost when compared to control. The enzyme activities amylase, cellulase, invertase, biochemical parameters namely protein; physiochemical parameters namely pH showed elevated levels after vermicomposting. The vermicompost applied plant Capsicum *annum* showed an increased shoot length and number of leaves when compared to the inorganic fertilizer applied plant. Hence , it was concluded that this quality of vermicompost obtained from the degradation of the Lady's finger waste by *Eudrilus eugeniae* is an effective organic manure which would facilitate increased uptake of the nutrients by the plants resulting in higher growth and yield.

To investigate the effects of vermicompost and chemical fertilizers on corn yield a study was carried out by Amyanpoori *et al* (2015) at Gomez village in Behbahan, Iran in cropping season of 2013. The experiment was design in factorial completely randomized block design with four replications. Two doses of vermicompost viz 5000 & 10000 kg ha-1 and three level of triple superphosphate i.e. 50, 75 & 100 % were used as study factors. Effect of these factors were accessed on chlorophyll content, plant height , harvest index, rows number per cob, cob per plant, 1000 seed weight, grains number in rows and yield. The study revealed a positive correlation between the level of selected factors and various growth parameters; increasing in the applied quantity of vermicompost and phosphorus also increased the cholorophyll content, growth, yield and other yield components of the plant.

***OCIMUM SANCTUM* (*Tulsi*)**

*Ocimum sanctum* belongs to plant family Lamiaceae. It has made important contribution to the field of science from ancient times as also to modern research due to its large number of medicinal properties. *Ocimum sanctum* is a popular home remedy for many ailments such as wound bronchitis, liver diseases, catarrhal fever, lumbago, hiccough, ophthalmia, gastric disorders, genitourinary disorders, skin diseases, various forms of poisoning and psychosomatic stress disorders (Ashoka *et al* ; 2009 ; Udupa *et al* ; 2006). Phytochemicals like flavonoids, tannins, terpenoid, saponins are present in the leaves and stem of most of the wild plants (Kayani *et al* ; 2007 ; Achakzai *et al* ; 2009). Similarly, the same are also present in *Ocimum sanctum*, while alkaloids are absent (Sutharsingh , 2011).

Preliminary phytochemical and proximate analysis of leaves and stem of three lamiaceae members i.e. Ocimum sanctum L. , Hyptis suaveolens Poit. and Plectranthus mollis L. was carried out by Koche *et al* (2011). The preliminary phytochemistry reveals that, these plants are rich in phytochemical constituents like Alkaloids, Flavonoids, Tannins, Saponins and cynogenic glycosides. The proximate analysis showed significant nutritional composition with high level of proteins, lipids, carbohydrate and fibers.

The proximate, minerals and preliminary phytochemical analysis of *Ocimum sanctum* leaves in comparison with stem were studied by Shafqatullah *et al* (2013). The nutritional analysis of *Ocimum sanctum* showed very low level of acidity and protein in their leaves and stems. Whereas the crude fiber was found to be maximum in stem and leaves. Results also showed that sugar contents were found to be low . The stem of *Ocimum sanctum* was nutritionally enriched in all respect as compare to leaves. The minerals analysis showed no remarkable change in the results. The quantities of Fe2+, Na+, K+ were higher in stems than leaves. The results of preliminary phytochemical analysis were same for both the samples and confirm the presence of various phytochemicals viz., alkaloids, glycosides, flavonoids, tannins, terpenoids and saponins. Quantitative analysis revealed maximum amount of saponins in stem in comparison leaves.

A comparative study of *Ocimum* sp. was conducted by Agarwal *et al* (2013) to examine the variability of qualitative and quantitative morphological characters present among the sixteen different genotypes of *Ocimum* species. This analysis of data showed that location had

significant effect on all the 6 characters. The interaction between genotype and environment was also pronounced for all the characters.

An investigation was carried out by Rahman *et al* (2014) to evaluate the effect of fertilizer and manure on the growth and yield of Tulsi and Pudina. The plant height, No. of branch/plant, No. of leaf/plant, Leaf length, 1000- fresh leaf weight and fresh yield were highest where cowdung was applied. The parameters were lowest where no manures were applied (control). The results showed that cowdung was the best for soil quality and growth and yield of Tulsi and Pudina medicinal plant.

Malav *et al* (2015) analysed forty-nine accessions of cultivated holy basil (*Ocimum tenuiflorum L.*) representing four phytogeographical regions of India were characterized for 18 qualitative and 14 quantitative traits . The analysis showed high degree of variation among studied accessions indicating rich diversity represented within the populations from different phytogeographical regions and relatedness among the morphotypes.

# OBJECTIVES

- To manage the leaf litter efficiently and use it as a resource.
- To make natural and cost- effective composts (traditional and commercial) from leaf litter.
- Physicochemical analysis and comparison of different composts prepared from leaf litter.
- Morphological analysis of *Ocimum sanctum* grown in different composts prepared.
- Phytochemical analysis of *Ocimum sanctum* grown in different composts prepared.
- To find out the most suitable compost for growing *Ocimum sanctum*.

# METHODOLOGY

The present study deals with utilization and management of leaf litter. The leaf litter collected will be used to prepare different composts. *Ocimum sanctum* (*Tulsi*) will be grown on different composts prepared.

The study involves the following steps:

- **Collection of leaf litter :**

  Leaf litter waste will be collected from residential areas.
- **Weighing of leaf litter :**

  After collection of leaf litter, it will be dried (if required ) and then measured by using appropriate instrument.
- **Preparation of different compost :**

  Five different types of composts will be prepared using leaf litter.

  **Group I : Amrut mitti (A)**

  First of all Amrut Jal (fermented solution) will be prepared by mixing 1 liter of cow dung, 1 liter of cow urine, 50 g black jiggery and 10 liters of water and keep it for 3 days. The mixture will be stirred 2 to 3 times in day, both clock and anti-clock wise. The final solution will be diluted to 1:10 times with water. For Amrut Mitti (fermented slurry) preparation, top soil from farms will be taken and mixed with previously dried green biomass (leaf litter). Before mixing, the dried green biomasses will be soaked in Amrut Jal for 24 h. Then soaked biomass and top soil will be spread one above the other and Amrut Jal will be sprinkle to moist the topsoil. Likewise 15 to 20 layers will be made. Every 7 days, the heaps will be tilled and sprinkled with Amrut Jal, the Amrut Mitti will be ready in 30 days. Then different types of seeds of different tastes will be sown. Then the saplings will be pruned after 21 days and left on heap. This process will be followed for 63 days. Then after one month compost will be ready.

  **Group II : Amrut mitti (B)**

  Amrut jal will be prepared by the same method mentioned above in group I. The method for Amrut Mitti preparation will initially be same as Amrut Mitti A. the compost

prepared in 30 days will be used in this group as compared to group I where compost is further processed.

**Group III : Culture compost**

For preparing compost by using composting culture, 0.02L of composting culture will be mixed in 2L of water. Then this diluted culture will be sprayed onto 20Kg of leaf litter. The waste will be mixed after every 15 days to maintain enough moisture till the compost is formed.

**Group IV : NS-DL (Nature's Suraksha-Liquid De-composer) compost**

For preparing compost by NS-DL, 1L of NS-DL will be with 20L of water and sprayed on leaf litter . The spray should cover the surface area uniformly.

**Group V: Vermicompost**

For preparing vermicompost , leaf litter will be collected from residential areas. Vermiculture of *Eisenia foetida*, commonly known as red worm will be used for preparation. It will be procured from *Rajasthan Gosewa Sangh*, Tonk Road, Durgapura, Jaipur. Vermicomposting units will be set up for leaf litter in earthen pots. Leaf litter waste will be cut into smaller pieces and mixed with cow dung in 50:50 ratio for vermicomposting. After mixing with cow dung the litter waste will be introduced into vermicomposting units. All the pots will be covered by a jute cloth and a wire mesh. Small holes will be drilled at the bottom of each pot for air circulation and easy drainage. The temperature and moisture content will be maintained by sprinkling adequate quantity of water every day and upside down mixing of waste as and when required.

**Group VI: Control**

For preparing control leaf litter and soil will be taken and mixed in 50:50 ratio. Then the mixture will be allowed to decompose till the compost is formed.

- **Physicochemical analysis of different compost :**

The different groups of composts will be analysed for different types of physicochemical parameters such as moisture content, temperature, pH, organic carbon, electrical conductivity, total nitrogen, available phosphorus, exchangeable potassium, sodium and

magnesium. Analysis of these parameters will be done by using different methods (Table 2).

| S.No. | Parameters | Method |
|---|---|---|
| 1. | Moisture Content (MC) | Jackson,1973 |
| 2. | Temperature | Jackson,1973 |
| 3. | pH | Jackson,1973 |
| 4. | Electrical conductivity (EC) | Jackson,1973 |
| 5. | Organic Carbon (OC) | Walkley and Black, 1934 |
| 6. | Total Nitrogen (N) | Singh and Pradhan, 1981 |
| 7. | Available Phosphorus (P) | Bhargava and Raghupathi, 1993 |
| 8. | Exchangeable Potassium (K) | Bhargava and Raghupathi, 1993 |
| 9. | Calcium (Ca) | Cheng and Bray,1951 |
| 10. | Magnesium (Mg) | Cheng and Bray,1951 |
| 11. | C/N ratio | |

**Table 2: Methods used for different physicochemical parameters**

- **Growing *Ocimum sanctum* in different compost :**

  After analysis of different physicochemical parameters *Ocimum sanctum* will be grown in different types of composts in triplicates.

- **Morphological analysis of *Ocimum sanctum* :**

  *Ocimum sanctum* grown in different compost will be analysed for different morphological parameters.

  The different types of morphological parameters which will be analysed are :

  - Duration of germination
  - Plant height
  - Leaf length
  - Leaf width
  - Leaf area
  - Branch no.

- Length of inflorescence
- Days of flowering

- **Phytochemical analysis of *Ocimum* sanctum :**

  *Ocimum sanctum* grown in different compost will be analysed for different phytochemical parameters.

  The different types of phytochemical parameters which will be analysed are :

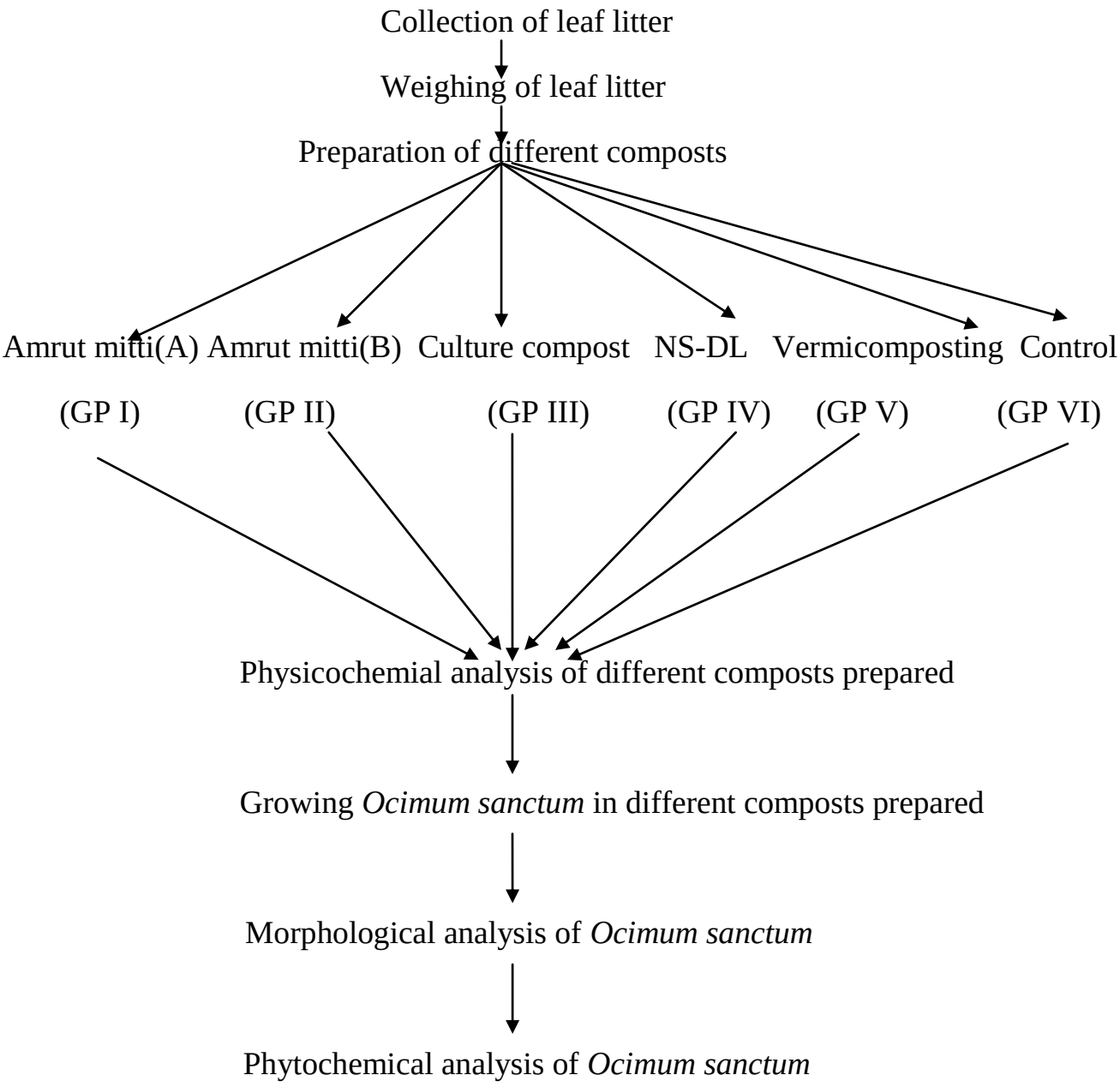
| S.NO. | Parameters | Method |
|---|---|---|
| 1. | Alkaloids | Harborne method , 1973 |
| 2. | Flavonoids | Harborne method , 1973 |
| 3. | Saponins | Brunner method , 1984 |
| 4. | Tannins | Iyengar method , 1995 |
| 5. | Essential oils | GC-MS method |

**Table 3: Methods used for different phytochemical parameters**

- **Statistical analysis:**

  The data and the results obtained will be analyzed statistically with appropriate tests.

## WORK PLAN


Collection of leaf litter
Weighing of leaf litter
Preparation of different composts
Amrut mitti(A)
Amrut mitti(B)
Culture compost
NS-DL
Vermicomposting
Control
(GP I)
(GP II)
(GP III)
(GP IV)
(GP V)
(GP VI)
Physicochemial analysis of different composts prepared
Growing *Ocimum sanctum* in different composts prepared
Morphological analysis of *Ocimum sanctum*
Phytochemical analysis of *Ocimum sanctum*

# SIGNIFICANCE

- This study will propose an alternative approach to waste management since the waste (leaf litter) will neither be land filled nor burnt but would be used as a resource.
- This study will reduce air pollution produced by leaf litter burning.
- Sustainable utilization and management of leaf litter through composting can be successfully applied in home gardening.
- Different types of nutrient rich composts prepared can be further used for organic farming to grow vegetables, fruits, cereals etc.
- Leaf litter utilization and management will help in making the residential areas cleaner and people will get to live in a sustainable environment.

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